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ECHO Development Notes

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PERENNIAL VEGETABLES AND NUTRITION

Eric Toensmeier summarizes information about perennial vegetables' potential contribution to human nutrition.

FACTORS TO CONSIDER WHEN SELECTING A PIGEON PEA VARIETY

Considerations discussed in this article can be helpful when selecting pigeon pea seeds, whether from ECHO or elsewhere.

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Perennial Vegetables and Nutrition

by Eric Toensmeier

[Eric Toensmeier is a long-time friend of ECHO. He has researched and promoted perennial vegetables for more than two decades, and written about them in books such as Paradise Lot and Perennial Vegetables. Toensmeier recently coauthored a paper with Rafter Ferguson and Mamta Mehra, called "Perennial Vegetables: A neglected resource for biodiversity, carbon sequestration, and nutrition" [http://edn.link/tones]. Here he summarizes the article's information about perennial vegetables' potential contribution to human nutrition.]

Perennial vegetables are a class of crops with great potential to address challenges like dietary deficiencies, lack of crop biodiversity, and climate change. Though some individual plant species have received significant attention (e.g. moringa), as a class, perennial vegetables have been largely overlooked. In this article, I provide an overview of perennial vegetables, focusing on their contribution to human nutrition.

Perennial Vegetables Defined

Perennials are plants that live for three years or more. Perennial vegetables (PVs) include trees and shrubs, cacti and succulents, palms and bamboos, and vines (both woody and herbaceous [plants with soft instead of woody tissue]). PVs also include herbaceous plants like ferns, grasses, and aquatic plants, and broad-leaved plants that are not woody. Some PVs are commonly grown as annuals (e.g., African eggplant, *Solanum aethiopicum*) or have both annual and perennial forms (e.g., Ethiopian kale, *Brassica carinata*). To fit our definition, PVs must provide multiple years of harvest, unlike some perennial plants that are used as vegetables but are killed by harvest (e.g., the harvest of palm hearts from single-stemmed palms).

As the name suggests, PVs are eaten as vegetables. Edible vegetative parts include shoots, leaves, cactus pads, and stems. Culinary herbs, which are only consumed in small quantities, are not considered PVs, although usage varies between cultures and regions so that a culinary herb in one place may be used as a vegetable in another.[1] Flowers, flower buds, and flower stalks (inflorescences) are also considered perennial vegetables. The classification of fruits is more complex, as there is no botanical distinction between vegetable fruits and dessert fruits. For example, a tomato is a fruit used as a vegetable. For our purposes, if a fruit is sweet and/or sour and mostly eaten out of hand or as a dessert, it is not considered a PV. However, if it is used in a salad, cooked in a stew, or otherwise served as part of a meal, we consider it a PV. In some cases, a fruit is a vegetable when unripe, and a dessert fruit when ripe; this is the case for papayas and mangos. Finally, the unripe seeds of many plants are used as vegetables, even if those seeds become dry staple crops when mature (like pigeon peas, which can be eaten as a vegetable when green and as a pulse when dried). Root crops and starchy fruits like bananas are excluded from our definition of perennial vegetables; they are more properly considered staple crops because they are grown for starch rather than vitamins. Root crops are also not properly perennial, as they must be dug from the soil to harvest the edible portion. Table 1 lists edible plant parts that are harvested from three different types of perennial plants (with annual crops also listed for reference).

[1] The southeast Asian species *Houttyunia cordata*, which has a strong taste of ginger and fish, is used as a vegetable in some regions and as a culinary herb in others.

Table 1. Edible plant parts, with examples given for annuals and for three types of perennial vegetable

Parts Used	Annual (for reference)	Perennial Herb	Perennial Vine	Woody Perennial
Leaves, shoots, and stems	spinach (*Spinacia oleracea*), lettuce (*Lactuca sativa*), cabbage (*Brassica oleracea* var. *capitata*)	belembe (*Xanthosoma sagittifolium*)	Malabar spinach (*Basella alba*)	chaya (*Cnidoscolus aconitifolius*)
Flower, flowerbuds	broccoli (*Brassica oleracea* var. *Italica*), squash blossom (*Cucurbita pepo* flowers)	globe artichoke (*Cynara scolymus*)	loroco (*Fernaldia pandurata*)	agati (*Sesbania grandiflora*)
Fruits used as vegetables	tomato (*Solanum lycopersicum*) eggplant (*Solanum melongena*), pumpkin (*Cucurbita pepo*)	African eggplant (*Solanum aethiopicum*)	chayote (*Sechium edule*)	moringa (*Moringa oleifera*)
Unripe seeds	pea (*Pisum sativum*), cowpea (*Vigna unguiculata*), sweet corn (*Zea mays* convar. *saccharata* var. *rugosa*)	(no species in this category)	lima bean (*Phaseolus lunatus*)	perennial pigeon pea (*Cajanus cajan*)

Nutrient Deficiencies

Nutrient deficiencies that cause health problems result from inadequate intake of vitamins, minerals, and other nutrients. Traditional malnutrition affects some two billion people, largely in the regions in which *EDN* readers live and/or work. Traditional malnutrition involves deficiencies in iron, zinc, Vitamin A, folate, and iodine (iodine is not found in large quantities in plants but is abundant in many seaweeds). Low levels of these nutrients in the diet can cause anemia, birth defects, and blindness in children. Deficiencies can also slow growth in children and impair immune systems.

By contrast, we can identify a second set of deficiencies, this one associated with the industrialized diet. Industrial diet deficiencies are a problem in countries like the United States, but also, increasingly, in the urban centers of the tropics. Industrial diets are often deficient in fiber, calcium, magnesium, and Vitamins A, C and E. Diseases that result from these deficiencies include diabetes, obesity, high blood pressure, heart disease, and osteoporosis.

One thing both sets of deficiencies have in common is a lack of fruits and vegetables in the diet. PVs can help address both.

Diversity of Perennial Vegetables

PV species are highly diverse and far more abundant than many people realize. Our study evaluated 613 cultivated PV species, representing seven percent of all cultivated crop species, and a third to half of all vegetable species.

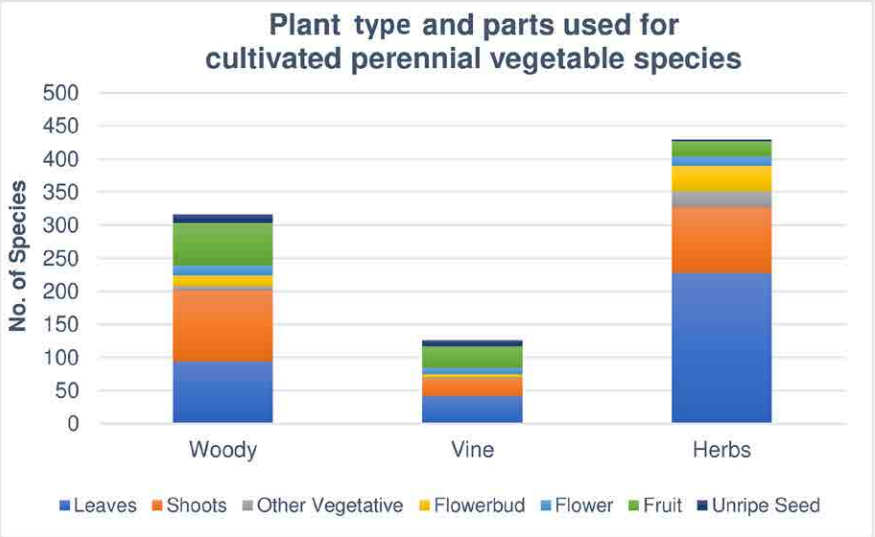

Figure 1. Plant type and parts used for cultivated perennial vegetable species. *Source:* Eric Toensmeier

Just over a third of cultivated PVs are woody plants, while half are herbaceous. The remainder are vines. Leaves are most commonly consumed, followed by shoots and then fruits. See Figure 1.

[2] About 5% of PVs were grown historically but are now abandoned, or are under development as experimental crops.

PVs are largely undomesticated. 61% are regional crops that are grown in gardens and farms in their native range, but have not spread elsewhere. They represent a powerful but neglected tool for improved nutrition. Chaya and moringa were in this category decades ago, but they are now grown around the tropics. Another 31% of PVs are minor global crops, grown at a modest scale outside of their region of origin. Only 3% are major commercial foods at the global level (including olive, avocado, and globe artichoke; a number of other commercially-grown PVs, like okra and leeks, are usually grown as annuals).[2]

Perennial Vegetable Nutrition

We used data from a set of reference vegetables and nutrition information from PVs to compare the levels of key nutrients needed to address nutrient deficiencies. For the reference vegetables, we chose common species that are marketed globally, with data tracked by the FAO. These include 22 commonly grown and widely marketed crops, including the annual reference species listed in Table 1.

In order to rank the nutrient levels of PVs, we set nutrient level categories based on those used for the reference vegetables (Table 2). Nutrient levels below the lowest amounts found in the reference vegetables are "very low." Within the range of the reference vegetables, the lowest third are "low," the middle third are "medium," and the upper third are "high." Crops with nutrient levels higher than the reference vegetables are "very high," and nutrient levels twice as high as the highest reference crop nutrient are "extremely high."

Table 2. Nutrient concentration categories based on reference crop nutrient levels (All values refer to amounts per 100 g fresh plant weight).

	Fiber	**Ca**	**Fe**	**Mg**	**Zn**	**Vitamin A**	**Vitamin B9**	**Vitamin C**	**Vitamin E**
	%	mg/100g	mg/100g	mg/100g	mg/100g	Mg Retinol Activity Equivalent	mcg/100g	mg/100g	mg/100g
Very low (VL)	0.00-0.39	0.00-11.84	0.00-0.46	0.00-11.24	0.00-0.15	0.00	0.00-13.49	0.00-5.64	0.00-0.04
Low (L)	0.40-1.45	11.85-86.71	0.47-1.01	11.25-35.75	0.16-0.29	0.00- 0.18	13.50-73.07	5.65-42.33	0.05-0.73
Medium (M)	1.46-2.50	86.72-161.57	1.02-1.55	35.76-60.26	0.30-0.42	0.19- 0.37	73.08-132.63	42.34-79.01	0.74-1.42
High (H)	2.51-3.85	161.58-238.70	1.56-2.11	60.27-85.50	0.43-0.56	0.38- 0.55	132.64-194.00	79.02-116.80	1.43-2.54
Very high (VH)	3.86-7.15	238.71-477.40	2.12-4.21	85.51-171.00	0.57-1.12	0.56- 1.11	194.01-388.00	116.81-233.59	2.55-5.08
Extremely high (XH)	7.16+	477.41+	4.22+	171.01+	1.13+	1.12+	388.01+	233.6+	5.09

See text of article (directly above this table) for a description of how we determined categories

We were pleased to learn that PVs have excellent potential to address nutrient deficiencies. An impressive 154 of the 240 PVs for which we had nutrient data were superabundant ("very high" or "extremely high") in at least one nutrient, and frequently in more than one. In fact, 23 species (10% of PVs for which we found data) were superabundant in four or more key nutrients needed to address deficiencies! We were especially

interested to note that trees with edible leaves were superabundant in more nutrients than any other type of PV.

For our study, we also determined the species with the highest levels of nutrients needed to address each of our two categories of nutrient deficiencies. We tallied a score for each species, giving three points for each nutrient that ranked "extremely high," two points for "very high," and one point for "high." If the combined score for a species totaled six or more, it was given a "multinutrient" ranking. Table 3 lists multinutrient species to address traditional malnutrition, and Table 4 lists multinutrient species to address industrial diet deficiencies. Both tables indicate, for each PV, which nutrients occur at high, very high, or extremely high levels.

Table 3. Multinutrient species to address traditional malnutrition

Name	Type of Perennial	Thermal Climate[Z]	Rainfall	Part Eaten[Y]	Fe[X]	Zn[X]	Vitamin A[X]	Folate[X]
Cnidoscolus aconitifolius (chaya)	Woody	Tropical	Humid, semi-arid, arid	Leaf	XH		XH	
Malva sylvestris (common mallow)	Perennial herb	Temperate, boreal/arctic	Humid	Leaf	XH	XH		
Manihot esculenta (cassava)	Woody	Tropical	Humid, semi-arid	Leaf	XH	XH	VH	
Momordica cochinchinensis (gac)	Perennial vine	Tropical	Humid	Leaf, unripe fruit, fruit	VH	VH	VH	H
Monochoria vaginalis (pickerel weed)[V]	Perennial herb	Tropical	Aquatic	Leaf	VH	VH	VH	
Moringa oleifera (moringa)	Woody	Tropical	Humid, semi-arid	Leaf, unripe fruit, flowerbud	XH	VH	VH	
Morus alba (white mulberry)[V]	Woody	Tropical, temperate	Humid, semi-arid	Leaf	XH	XH	VH	
Persicaria barbata (knot grass)[V]	Perennial herb	Tropical	Humid	Leaf	XH	VH		VH
Pterocarpus mildbraedii (padouk blanc [French])	Woody	Tropical	Humid	Leaf	XH	XH		
Salix reticulata (netleaf willow)	Woody	Boreal/arctic	Humid	Leaf	XH	XH		
Senna obtusifolia (sicklepod)[V]	Woody	Tropical	Humid	Leaf	XH		XH	
Senna sophera (kasundi [Hindi])[V]	Woody	Tropical	Humid	Leaf	VH	VH	VH	H
Solanum aethiopicum (Ethiopian eggplant)	Perennial herb	Tropical[W]	Humid, semi-arid	Leaf	XH	VH	VH	
Toona sinensis (Chinese toon)	Woody	Tropical, temperate	Humid, semi-arid	Leaf	XH	XH	XH	
Ulmus pumila (Siberian elm)[V]	Woody	Temperate, boreal/arctic	Humid, semi-arid, arid	Fruit	XH	XH		
Vitis vinifera (wine grape)	Perennial vine	Tropical, temperate, boreal/arctic	Humid, semi-arid	Leaf	VH	VH	VH	

[Z]"Tropical" indicates lowland tropics, highland tropics, and/or subtropics. "Temperate" indicates warm temperate and/or cold temperate. "Boreal/arctic" indicates boreal and/or arctic.
[Y]Where multiple plant parts are listed, the nutrient rank is obtained by combining nutrition information for all the edible parts.
[X]See Table 2 and surrounding text for a description of the nutrient concentration categories (XH, VH, H).
[W]Suitable for cultivation as an annual throughout temperate zones as well.
[V]Species considered as weedy in one or more locations.

Table 4. Multinutrient species to address industrial diet deficiencies

Name	Type of Perennial	Thermal Climate[Z]	Rainfall	Part Eaten[Y]	Fiber[X]	Ca[X]	Mg[X]	Vitamin A[X]	Vitamin C[X]	Vitamin E[X]
Asclepias syriaca (common milkweed)[V]	Perennial herb	Temperate	Humid, semi-arid	Leaf		VH		VH	XH	
Atriplex halimus (saltbush)	Woody	Tropical, temperate	Humid semi-arid, arid	Leaf	VH	XH	XH			
Bambusa polymorpha (Burmese bamboo)	Woody	Tropical	Humid	Shoot	VH	VH	VH			
Cnidoscolus aconitifolius (chaya)	Woody	Tropical	Humid semi-arid, arid	Leaf		VH	VH	XH	VH	
Coccinia grandis (ivy gourd)[V]	Perennial vine	Tropical	Humid	Leaf, unripe fruit	VH			H		XH
Dicliptera chinensis (Chinese foldwing)[V]	Perennial herb	Tropical	Humid	Leaf		VH		VH		XH
Epilobium angustifolium (willow herb)[V]	Perennial herb	Temperate, boreal/ arctic	Humid, semi-arid	Shoot	H	H	VH		VH	
Gnetum gnemon (Spanish joint fir)	Woody	Tropical	Humid	Leaf	VH		H	H	VH	H
Limnocharis flava (yellow velvetleaf)[V]	Perennial herb	Tropical	Aquatic	Leaf, stem, flowerbud	VH	XH	XH	H		
Manihot esculenta (cassava)	Woody	Tropical	Humid, semi-arid	Leaf	H	VH		VH	VH	XH
Momordica cochinchinensis (gac)	Perennial vine	Tropical	Humid	Leaf, unripe fruit, fruit	H	VH		VH	VH	XH
Moringa oleifera (moringa)	Woody	Tropical	Humid, semi-arid	Leaf, unripe fruit, flowerbud	H	VH	VH	VH	VH	H
Morus alba (white mulberry)[V]	Woody	Tropical, temperate	Humid, semi-arid	Leaf	VH	VH	VH	VH	VH	
Pisonia umbellifera (umbrella catchbirdtree)	Woody	Tropical	Humid	Leaf	VH	VH	VH			
Sauropus androgynous (katuk)	Woody	Tropical	Humid	Leaf				VH	VH	XH
Senna obtusifolia (sicklepod)	Woody	Tropical	Humid	Leaf		VH		XH	VH	
Senna sophera (kasundi [Hindi])[V]	Woody	Tropical	Humid	Leaf		H		VH	VH	VH

Table 4. Multinutrient species to address industrial diet deficiencies

Name	Type of Perennial	Thermal Climate[Z]	Rainfall	Part Eaten[Y]	Fiber[W]	Ca[W]	Mg[W]	Vitamin A[W]	Vitamin C[W]	Vitamin E[W]
Sesbania grandiflora (vegetable hummingbird)	Woody	Tropical	Humid	Leaf	XH	VH	VH		H	H
Silene vulgaris (maiden's tears)	Perennial herb	Temperate, boreal/ arctic	Humid, semi-arid	Leaf	VH			VH		XH
Solanum aethiopicum (Ethiopian eggplant)	Perennial herb	Tropical[W]	Humid, semi-arid	Leaf		VH	VH	VH		XH
Toona sinensis (Chinese toon)	Woody	Tropical, temperate	Humid, semi-arid	Leaf		VH		XH	VH	XH
Trichanthera gigantea (nacedero)	Woody	Tropical	Humid	Leaf		XH	XH			
Urtica dioica (stinging nettle)[V]	Perennial herb	Temperate, boreal/ arctic	Humid	Leaf	H	VH	H		VH	XH
Vitis vinifera (wine grape)	Perennial vine	Tropical, temperate	Humid, semi-arid	Leaf	XH	VH	VH	VH		H

[Z]"Tropical" indicates lowland tropics, highland tropics, and/or subtropics. "Temperate" indicates warm temperate and/or cold temperate. "Boreal/arctic" indicates boreal and/or arctic.
[Y]Where multiple plant parts are listed, the nutrient rank is obtained by combining nutrition information for all the edible parts.
[X]See Table 2 and surrounding text for a description of the nutrient concentration categories (XH, VH, H).
[W]Suitable for cultivation as an annual throughout temperate zones as well.
[V]Species considered as weedy in one or more locations.

A few standout species are ranked as multinutrient for both forms of deficiencies. These nutritional powerhouses are:

- woody plants - chaya, cassava leaf, moringa, white mulberry (varieties with palatable leaves), *Senna obtusifolia* and *S. sophera* (both of which are strongly laxative when leaves are mature), and *Toona sinensis*;
- vines - grape leaves and the perennial cucurbit *Momordica cochinchinensis* (both vines); and
- perennial herb (often grown as an annual) - African eggplant (*Solanum aethiopicum*).

While this article highlights PVs that rank highly as multinutrient crops, some less-common annuals do as well. Many of these are offered by ECHO. For traditional malnutrition, ECHO offers the multinutrient species *Amaranthus cruentus* (grain amaranth), *Celosia argentea* (Lagos spinach), *Corchorus olitorius* (Jute), *Solanum scabrum* (African nightshade), and *Vigna unguiculata* (cowpea). Both *Corchorus olitorius* and *Vigna unguiculata* are also multinutrient species for industrial diet deficiencies.

Other Benefits and Drawbacks of Perennial Vegetables

Perennial vegetables offer many advantages to smallholders and gardeners in the tropics. For example, perennial crops sequester carbon and therefore play a role in climate change mitigation. They can also help farmers adapt to climate change, such as when PVs have deep roots that help them resist droughts.

Perennial crops diversify production systems, often offering food when other crops are not available. For example, many trees with edible leaves, when coppiced, will continue to offer vegetables well into the dry season. Also, PVs can sometimes be produced in areas not suited to annual crops. Some perennial vegetables, including aquatic species, can be grown in very wet areas. Others are suited to shade, making them ideal for the understory of agroforestry systems.

Perennial crops also bring some disadvantages. For one thing, they can be difficult to acquire. It may be challenging to adapt PVs to local cooking styles, and some PVs are toxic unless properly processed. Finding markets for unfamiliar crops can be difficult. Many PVs are propagated by cuttings or through other vegetative means, which makes them vulnerable to viruses and some other diseases.

With any new crop, including perennials, potential weediness is a concern. Tables 3 and 4 indicate plants that are considered weeds in various locations. Be very cautious about planting these in new areas—but do plant them where they are native! These plants represent a source of nutrition that is easily overlooked. This concept is described more fully by Rinaudo (2002) in *EDN* 77 [http://edn.link/qaag7k].

Note that nutrition, flavor, productivity and ease of cultivation are independent of each other. These vegetables will only be nutritious if they can be produced easily and taste good. As ECHO staff members have noted, it is not as easy to eat 100 grams of moringa as it is to eat 100 grams of spinach. Perhaps the best approach, recommended by Dr. Martin Price (ECHO founder), is to "eat like a deer, not like a cow" (i.e. consume modest amounts of a large diversity of vegetables, instead of large amounts of one single species).

Conclusion

The world's farmers and gardeners who selected these species and brought them into cultivation deserve our heartfelt thanks. The hundreds of cultivated species of PVs are here when they are needed, to address deficiencies that impact billions of people, to turn unproductive parts of farms and gardens into food and income, and to address climate change. We find it especially promising that trees with edible leaves are the most nutritious category and contain some of the world's most nutritious vegetables, as these species have a desirable climate impact and are relatively easy to grow.

These valuable PV crops should be promoted. Efforts should begin with species native to a region, both to minimize potential invasiveness and to work with species that are more familiar to people in the community. With over 600 species to choose from, hailing from all over the world, there is a PV for almost anywhere that people grow food. The paper upon which this article was based is available online; it includes links to the full data set, which can be used to identify suitable species for any

given region. It also includes nutrient data on annual crops for which data were available.

Though the data in the online article are extensive, they are incomplete. Only for a few species of PV were we able to find all of the nutrients we were looking for; many important species had no data at all.

ECHO has been offering many of these species for decades, and our team was very pleased to be able to offer additional research to back up this important work.

Resources

The full article is available online for free download at http://edn.link/tones.

ECHO's Seed Bank is a source of seeds and cuttings for many of the PVs highlighted in this article.

From ECHO's Seed Bank: Factors to Consider when Selecting a Pigeon Pea Variety

by Tim Motis

Benefits of pigeon pea

Pigeon pea (*Cajanus cajan*) is a multi-use legume well suited to rainfed agriculture in hot, dry areas. Pigeon pea plants grow into erect (1-4 m tall) shrubs (Figure 2) that can live up to five years, though pigeon pea is usually grown for only one or two years. Edible, nutritious seeds, produced in pods, can be made into a variety of foods. In India, a thick stew called dahl is made from dry, split seeds with the seed coat removed (Singh, 1995). Pods and seeds can be collected at an immature/green stage and cooked as a vegetable. Other parts of the plant are also useful; leaves can be fed to animals, and dry stems serve as fuel for starting cooking fires.

Pigeon pea grows well in poor soils. It belongs to the legume (Fabaceae) family of plants of which many members, in association with bacteria that colonize the roots, convert atmospheric nitrogen into a form that plants can use. This means pigeon pea plants do not need as much soil nitrogen as crops like maize. Nitrogen obtained from the air and incorporated into pigeon pea plants will be added to the soil when the plants die, as long as the residue is kept in the field. Additionally, pigeon pea's deep roots grow through hard layers of soil (called hard pans), improving water infiltration and soil aeration (Arihara *et al.*, 1991). These soil improvements benefit crops that are planted with and/or after pigeon pea.

Many varieties of pigeon pea are available. In the remainder of this article, we summarize varietal differences and mention some farmers' preferences. These considerations can be helpful when selecting seeds, whether from ECHO or elsewhere.

Varietal differences

Duration

Pigeon pea varieties are labeled as short-, medium-, or long-duration, depending on how long (after seeds are sown) the plants flower or the pods reach maturity (Table 5).

Figure 2. Pigeon pea plants growing in dry, sandy soil. *Source*: Tim Motis

Table 5. Grouping of pigeon pea varieties based on how many days (from the time seeds are planted) it takes for half of the plants to flower or for most of the pods to mature.

Maturity category	Days to 50% flowering[Z]	Days to pod maturity[Z]	Varieties in ECHO's seed bank
Short	106	<150	'Georgia-1', 'Georgia-2', and 'ICPL 88034'
Medium	123	151-180	
Long	144	>180	'Agroforestry Select', 'Caqui', 'ICPL 8151'

[Z]Data from Egbe and Vange (2008), who cite Reddy (1990) as the source for days to pod maturity ranges. Nyirenda Yohane *et al.* (2020) measured days to maturity as days from seeding until 75% of the pods in a plot turned brown.

❸ Infonet-Biovision [http://edn.link/gzxhf3] (2019) shows nutritional composition of pigeon pea seeds, gives planting recommendations, and explains how to integrate it with other crops.

Figure 3. Various colors of dry pigeon pea seeds. *Source:* ECHO staff

Traditional pigeon pea varieties tend to be medium- and long-duration types. These varieties will have deeper roots and larger plants (with more biomass for soil mulch) than short-duration varieties. Most medium- and long-duration varieties are 'indeterminate,' meaning that growth continues after flowering. Many short-duration varieties, on the other hand, are 'determinate' and stop growing after they flower. Indeterminate varieties tend to grow taller and produce pods over a longer period; this makes them especially desirable for household use. For field planting, determinate varieties that produce pods on a compact plant within a short window of time are easier to harvest. Short-duration types have been an important focus of breeding efforts (e.g., by ICRISAT [http://edn.link/2mg7y4]) in recent decades. Their early seed production gives an important advantage in regions with short rainy seasons.

Sensitivity to day length

Medium- or long-duration varieties typically require short days (12-13 hours) to flower (Carberry *et al.*, 2001), which means these varieties can only be harvested during the time of year with shorter days. Short-duration varieties offer farmers greater flexibility—for example, they can time their plantings so that they have grain to sell when they can get the best return on investment.

Figure 4. Example of pigeon pea pods (left) and seeds (right) picked at full size while still fresh, to be cooked and eaten as a vegetable. *Source:* Tim Motis

Seed color and size

Pigeon pea seed colors include black, brown, purple, or white (Figure 3). Some are uniform in color while others are speckled. Pigeon pea seed size is described in terms of weight per 100 seeds. The 100-seed weight ranges from 4 to 24 g between pigeon pea varieties (Narayanan *et al.*, 1981).

Vegetable versus pulse

While pigeon pea is usually grown for its dry beans (pulse), pods of some varieties are harvested early (before drying on the plant) and consumed as a vegetable (Figure 4). ECHO's seed bank carries a purple vegetable type called 'ICP 7035'.

Farmer preferences

Many factors influence which varieties farmers choose to grow. These factors include cultural preferences, taste, visual appearance, cooking time, growing constraints, and seed availability. A study in Malawi showed that farmers preferred varieties with white/cream seeds, which they felt had good cooking quality (Nyirenda Yohane *et al.*, 2020).[4]

[4] 'Caqui' is a white-seeded variety offered by ECHO.

For vegetable varieties of pigeon pea, long pods, large seed size, and sweetness are preferable traits (Saxena *et al.*, 2010). The 'ICP 7035' variety [available from ECHO's seed bank] has a sugar content of up to 8.8%, quite a bit higher than the 5% sugar content of most vegetable varieties (Saxena *et al.*, 2010).

Seeds that cook quickly require less food preparation time and less firewood. Farmers in Benin identified this as an important trait (Ayenan *et al.*, 2017). Jambunathan and Singh (1981) reported an inverse relationship between cooking time and seed weight, and between cooking time and water absorption. Apparently, large seeds took less time to cook than small seeds because their seed coats allowed for faster absorption of water.

Sometimes farmers choose varieties that enable them to avoid or minimize pest problems. Pod borers (*Helicoverpa* sp.) are a pest on pigeon pea plants. Farmers in India were interested in varieties with resistance to pod borers, and some grew a variety called 'Durga' that flowers and produces pods before borer populations peak (Singh *et al.*, 2020). [Pod borer larvae can also be shaken off the plants and collected on a sheet; Berkelaar, 2004].

Closing thoughts

Farmers may already be growing pigeon pea in your region/country. Before promoting pigeon pea, find out what varieties farmers grow and how pigeon pea products are used. Valuing local varieties keeps them from disappearing and, thus, helps preserve the genetic diversity of the crop. If the community expresses an interest in or need for other varieties, consider the factors mentioned in this article when selecting varieties to evaluate within your context. Browse the ECHO Online Seed Catalog [http://edn.link/seeds] to see what varieties we carry and how to obtain trial packets of seeds.

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Echoes from our Network: 2020 ECHO International Agriculture Conference

by Bob Hargrave

This year ECHO held its 27th Annual Conference--but with a twist. Like many events, meetings, and occasions this year, the ECHO conference took place online (Figure 5). This meant the loss of the excellent face-to-face networking that has always been a hallmark of past conferences; however, a major advantage was that hundreds of people from around the world, who would not have been able to travel to Fort Myers in normal years, were able to participate. While participants were unable to be on the ECHO farm for workshops, the online one-day event included multiple short videos (lightning talks) that highlighted techniques being demonstrated at ECHO.

Almost 700 people from 69 different countries registered on the Whova™ app for the event. The conference featured four plenary speakers, 12 lightning talks and 15 breakout sessions. Most of these are now available to view on ECHOcommunity.org [http://edn.link/y3m7ym].

Plenaries -- The four plenary talks addressed farmer motivation (Neil Miller), extension services during crises (former ECHO intern, Dr. Kristin Davis), global health issues (Dr. Gen Meredith), and the role of agroforestry in reducing global hunger (Tony Rinaudo). Below are a few comments on two of these talks.

Figure 5. Studio set up at ECHO Florida for the 2020 virtual conference. *Source:* Stacy Swartz (left) and Tim Albright (right)

Dr. Davis explained some of the unique challenges facing extension providers during crises and times of disaster recovery. She presented examples of crises that undermined food security, including outbreaks of avian flu, Ebola, locusts and now COVID-19. Dr. Davis explained how extension services adapted to meet these challenges. Key insights learned from these experiences can help extension providers prepare for future events.

Extension providers can cautiously embrace technology for the way it allows them to share information and interact with farmers. In addition to providing individuals with technical skills, extension organizations should also provide training in critical thinking, communication, and emotional intelligence. They should empower staff to act when abnormal situations arise.

Organizations need to have flexible and collaborative structures built in. The Global Forum for Rural Advisory Services (GFRAS) has created a free online "New Extensionist Learning Kit" with self-directed modules to "clearly [articulate] the role of EAS [extension and advisory services] in the rapidly changing rural context." It is available online at http://edn.link/9hf4ae.

Tony Rinaudo has contributed to ECHO conferences and publications for decades. (For example, see the ECHO *Technical Note* on Farmer Managed Natural Regeneration (FMNR) -- http://edn.link/tn-65.) It was inspiring to have him as a plenary speaker this year. Rinaudo first described the discovery of the "underground forest" many decades ago, then talked about the subsequent promotion and success of FMNR. In Niger, tree density increased from 4 trees/ha to 40 trees/ha in roughly 10 years, and around 5 million hectares of land were restored after about 20 years. Rinaudo then described more recent work in Uganda and Ethiopia, and stated that FMNR has been promoted in at least 25 countries.

In 2017, Rinaudo returned to Niger. He commented that "What had been a vicious cycle of degradation and poverty had become a virtuous cycle of restoration and relative prosperity." [http://edn.link/j3y32c]

Lightning talks – The ECHO farm was visited virtually via the lightning talks, short videos that had been filmed and edited beforehand. One highlighted a recent demonstration of several planters specifically designed for Conservation Agriculture. ECHO Florida's Appropriate

Technology Manager, Elliott Toevs, with the aid of others, demonstrated the planters' performance for planting cowpea, comparing the time, effort, and effectiveness of each one. Anyone practicing or interested in Conservation Agriculture will find this video [http://edn.link/je4rxh] helpful.

Breakout sessions-- Following Dr. Gen Meredith's plenary talk on public health, a breakout session featured a question period with Andrea Paola Guzmán Abril, who serves with the Maya Health Alliance in Guatemala. Several topics were discussed:

- How to motivate families to eat a healthier diet
- How to introduce unfamiliar foods using traditional cooking methods. For example, Maya Health Alliance has conducted cooking classes on how to incorporate chaya into traditional foods such as tortillas, rice, pasta and pudding
- Resources for teaching people who cannot read
- Finding nutritional information for underutilized crops (hint:http://edn.link/6dtpch)

During this one-day conference, an amazing amount of information was shared, with excellent discussion from attendees around the world. It would take days to watch every presentation, but we believe many of you will find sessions that are relevant for your situation. The conference recordings are available on ECHOcommunity.org [http://edn.link/y3m7ym]. We hope you find them informative and inspiring.

Books, Websites, and Other Resources: ECHOcommunity Mobile App Announcement

ECHO is excited to introduce our new mobile app! We represent a network of nearly 20,000 members and we have provided resources to farmers and development workers for over 30 years. ECHOcommunity.org contains thousands of documents and videos that are relevant for those working to end world hunger; the new mobile app enables these resources to be stored directly on a mobile device so that they can be viewed and shared with others while offline (Figure 6).

Figure 6. Different ECHOcommunity mobile app pages. *Source:* Steve Snyder

The new ECHOcommunity Mobile App also allows farmers to track and evaluate crops. Seeds (whether procured from ECHO seed banks around the world or from other sources) can be tracked from planting to harvest through detailed digital records. Farmers can track weather events, inputs, pests, diseases, and many other factors. They can also add notes and pictures. The data are synchronized to internet-based storage when internet is available, and retained on the device when there is no internet connection. The app is able to function on very low bandwidths.

The app is available in English through Apple [http://edn.link/apple] and Android [http://edn.link/android] app stores. Translation is currently underway for an additional nine languages. Search for 'echocommunity' (no spaces) in your app store to download the app to your mobile device now. If you find the app useful, please share it with others!

ECHO Florida

Mark your calendars!

ECHO Florida is offering two conference events this year, one online and one in-person.

Online Forum on Seed Saving

Online Only
August 19th, 2021

ECHO's 28th Annual International Agriculture Conference

ECHO's Global Farm in Florida, USA
November 16-18, 2021

Upcoming Events